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1. Learning Outcomes

After studying this module, you shall be able to:

- ❑ Know the methods of measuring elasticity of demand
- ❑ Understand straight line method of elasticity
- ❑ Understand outlay method of elasticity
- ❑ Understand arc method of elasticity
- ❑ Compare straight line and demand curves' elasticity

2 Methods of measuring price elasticity of demand

The price elasticity of demand measures the responsiveness of percentage change in price to percentage change in quantity demanded. There are three popular methods for measuring price elasticity of demand. These are as follows:

(i) Straight line method

(ii) Outlay method

(iii) Arc elasticity

We will explain these methods one by one.

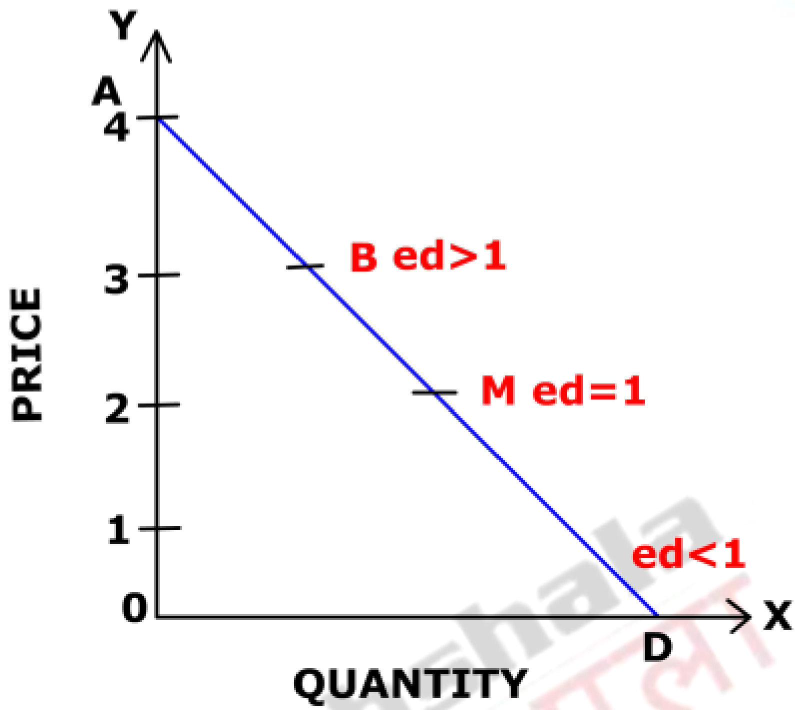
3. Straight line method of elasticity

It is the simplest method to calculate price elasticity. There is a simple rule for calculating price elasticity of a demand curve, i.e., the elasticity of a straight line at a point is given by the ratio of the length of the line segment below the point to the length of the segment above it.

$$e_p = \frac{\text{lower segment}}{\text{upper segment}}$$

This can be shown through diagram 1. At the top of the line, a very small percentage price change induces a very large percentage quantity change; therefore the elasticity is extremely large.

Figure1



Elasticity of Straight Line

Price elasticity is relatively large when we are high up the linear demand curve DD. The same rule is used here to calculate price elasticity, i.e., lower segment divided by upper segment. At point B in the figure, elasticity of demand is the ratio of segment BZ to the segment AB. Looking at axes, we find the ratio is 3. Therefore, price elasticity at point B is 3. Similarly for point R, demand at this point is inelastic and the elasticity is ½. Finally, at point M, the elasticity is one because ratio of the lower segment and upper segment is one. The calculation of price elasticity along a linear demand curve is shown below in the table:

Table 1: Calculation of price elasticity along a linear demand curve

Q	ΔQ	P	ΔP	$\frac{Q_1+Q_2}{2}$	$\frac{P_1+P_2}{2}$	$E_D = \frac{\Delta Q}{(Q_1+Q_2)/2} \div \frac{\Delta P}{(P_1+P_2)/2}$	
0		6					
	10		2	5	5	$\frac{10}{5} \div \frac{2}{5} = 5$	Elastic
10		4					
	10		2	15	3	$\frac{10}{15} \div \frac{2}{3} = 1$	Unit Elastic
20		2					
	10		2	25	1	$\frac{10}{25} \div \frac{2}{1} = 0.2$	Inelastic
30		0					

For the mathematically inclines, we can show the algebra of elasticities for straight line (linear) demand curves. We begin with a demand curve, which is written as Q= a-bP.

The demand elasticity at point (P_o , Q_o) is defined as

$$e_D = \frac{\%\Delta Q}{\%\Delta P}$$

$$= \frac{\Delta Q / Q_O}{\Delta P / P_O}$$

$$= \frac{\Delta Q / \Delta P}{P_O / Q_O}$$

This implies that the elasticity at point (P_o, Q_o) is

$$E_{D=} b(P_O / Q_O)$$

Note that the elasticity depends upon the slope of the demand curve, but it also depends upon the specific price and quantity pair. In the diagram 1, we have seen that linear demand curve starts out with high price elasticity, where price is high and quantity is low, and end up with low elasticity, where price is low and quantity is high.

4. Outlay or total expenditure method of elasticity of demand

Many businesses want to know whether raising prices will lower or raise the revenue. This question is of strategic importance for businesses like airlines, baseball teams, and magazines. They are always interested in knowing whether it is worthwhile to raise price and whether the higher prices would make up for demand reduction.

The sellers earn revenue in the form of expenditure incurred by the consumers. Total revenue is by definition equal to price times quantity (P*Q). Change in the price of a good brings a change in the revenue. The changes in the revenue are dependent on the price elasticity of the good. The three situations that may arise due to change in the price of the good and its impact on the revenue are summarised below in the following table 2.

Table 2: Explaining Elasticities

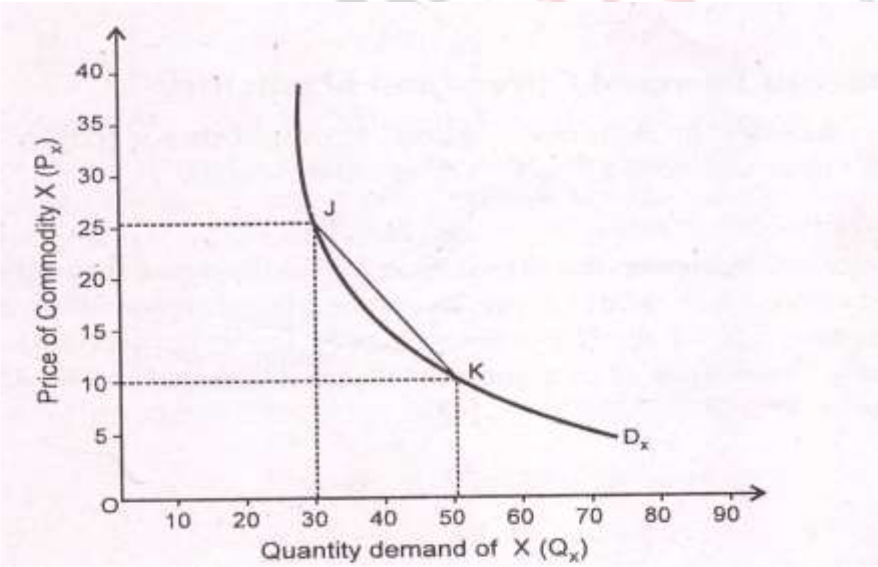
Change in the Price	Change in Quantity Demanded	Explanation	E_d	Terminology
Falls	Rises in a greater proportion	Expenditure increases	e>1	Elastic Demand
Falls	Rises in the same proportion	Expenditure remains constant	e=1	Unitary Elastic Demand
Falls	Rises in lesser proportion	Expenditure falls	e<1	Inelastic Demand

Now a day concept of elasticity is widely used by businesses to divide consumers into groups with different elasticities and then accordingly decisions are taken. This technique has been extensively used by the airlines. Another example is software companies, which have a wide range of products with different prices. These companies by dividing consumers into different categories exploit elasticities. For example, if the consumer is willing to buy a new operating system immediately, your elasticity is low and in such a situation the seller will get benefit by charging a relatively higher price. On the other hand, if the consumers are not in hurry to upgrade their systems, it means elasticity is high and consumer can search around for the best price. In such a situation, the seller will try to find a way to make the sale by charging relatively low price.

5.Arc method of elasticity of demand

The measure of elasticity of Demand between two finite points is known as Arc Elasticity. It is relevant where change in price and consequent change in demand is substantial. Arc elasticity is a measure of average of responsiveness of the quantity demanded to a substantial change in price.
In figure 2, the measure of elasticity between point J and point K is known as arc elasticity. The elasticity between point J and K can be calculated by substituting values of ΔP & ΔQ into elasticity.

Figure 2: Arc elasticity



ΔQ=43-75=-32

ΔP=20-10=10

$$e_p = \frac{\Delta Q}{\Delta P} \cdot \frac{P_O}{Q_O}$$

$$= \frac{-32}{10} \cdot \frac{20}{43}$$

= 1.49

This means one percent decrease in price of the commodity X means results in 1.49 percent increase in demand for it.

The arc elasticity should be measured carefully because co-efficient may differ between the same two finite points on a demand curve. For instance, if direction of change in price is reversed, coefficients may be different. A reverse movement from Point K to J gives

P=10

ΔP=10-20=-10

Q=75

ΔQ=75-43=32

By substituting these values into elasticity formula, we get-

$$= \frac{-32}{10} \cdot \frac{10}{75}$$

= 0.43

Thus, while measuring price elasticity, direction of change of price change should be carefully noted, otherwise it shall give misleading results. It is important to note that the elasticity between the midpoints and the upper point J or lower point K will be different. Thus, this method does not measure one point elasticity.

6. Comparison between straight line and demand curves' elasticity

The elasticity measured on a finite point of a demand curve is called point elasticity. The Point Elasticity of demand is defined as proportionate change in quantity demanded in response to a very small change in price. The concept of point elasticity is useful where change in price and consequent change in quantity demanded are very small. The point elasticity can be expressed as-

To measure point elasticity, let us suppose a linear demand curve AB and we measure price elasticity at point P as shown in figure3.

We know that Price= PQ

Quantity= OQ

The derivative $\frac{\partial Q}{\partial P}$ is the slope of demand curve AB .The slope of straight line demand curve AB at point P is geometrically given by QB/PQ

i.e $\frac{\partial Q}{\partial P} = \frac{QB}{PQ}$

Since at Point P, P=PQ and Q=OQ

substituting these values ignoring the (-) sign we get

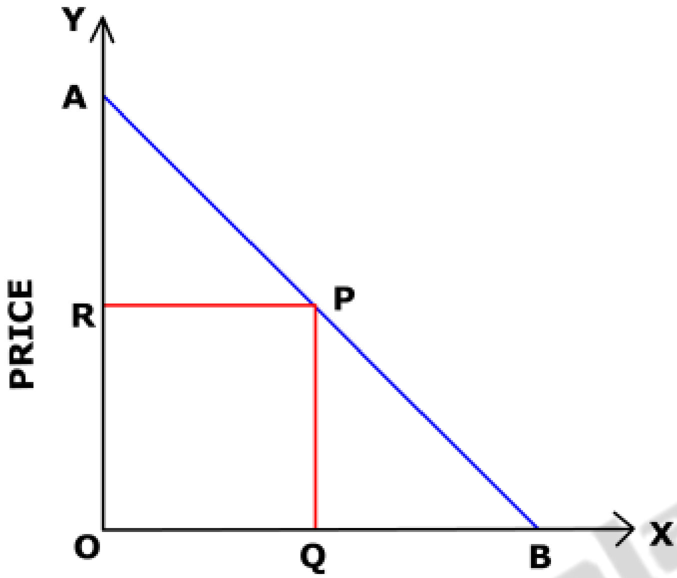
$$e_p = \frac{QB}{PQ} \cdot \frac{PQ}{OQ} = \frac{QB}{OQ}$$

Geometrically

$$\frac{QB}{OQ} = \frac{PB}{PA}$$

This may be proved as follows. If we draw horizontal line from P to the vertical axis, there will be three triangle ∆ AOB, ∆ ARP, ∆PQB (Figure3) in which ∠AOB, ∠ARP and ∠PQB are right angles. Therefore, the corresponding angles of the three triangles will always be equal and hence ∆ AOB, ∆ ARP, ∆PQB are similar triangles.

Figure 3: Point Elasticity of linear demand curve



Point Elasticity of Linear Demand curve

According to geometrical Properties of similar triangles, the ratio of two sides of similar triangle is always equal to the ratio of corresponding sides of the other triangles Therefore in Δ PQB and Δ ARP

$$\frac{QB}{PB} = \frac{RP}{RA}$$

Since RP =OQ by substituting O for RP in above equation we get

$$\frac{QB}{PB} = \frac{OQ}{PA}$$

By proportionality rule Therefore

$$\frac{QB}{OQ} = \frac{PB}{PA}$$

It may thus be concluded that price elasticity at point P is given by

$$e_p = \frac{PN}{PM}$$

Measuring Point Elasticity on Non Linear demand Curve:

Suppose we want to measure the elasticity of demand curve DD at Point P, let us draw a tangent line AB to the Demand curve DD at point P. Since the Demand Curve DD and the line AB pass through the same point (P). The slope of the demand curve and that of the line at this point is the same. Therefore, the elasticity of the demand curve DD at the point will be equal to the elasticity of the demand line AB at the Point P can be measured (ignoring minus sign)

$$e_p = \frac{P}{Q} \cdot \frac{\partial Q}{\partial P}$$

$$\frac{PQ}{OQ} \cdot \frac{QB}{PQ} = \frac{QB}{OQ}$$

Geometrically QB/OQ = PB/PA

Table 1: Calculation of price elasticity along a linear demand curve

Q	ΔQ	P	ΔP	$\frac{Q_1 + Q_2}{2}$	$\frac{P_1 + P_2}{2}$	$E_D = \frac{\Delta Q}{(Q_1 + Q_2)/2} \div \frac{\Delta P}{(P_1 + P_2)/2}$
0		6				
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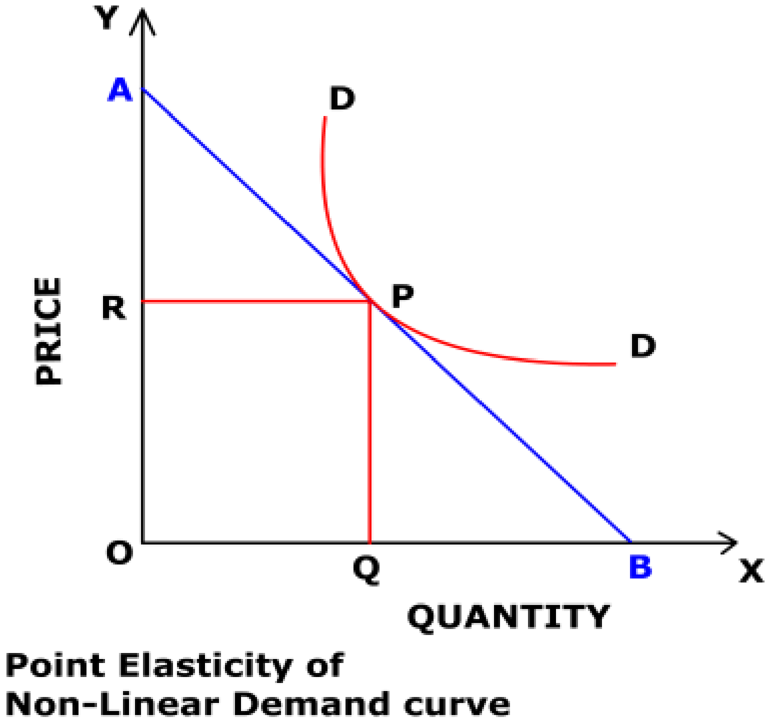
20		2				
	10		2	25	1	$\frac{10}{25} \div \frac{2}{1} = 0.2$ Inelastic
30		0				

Figure 4: Point elasticity of non linear demand curve



6. Comparing Elasticities

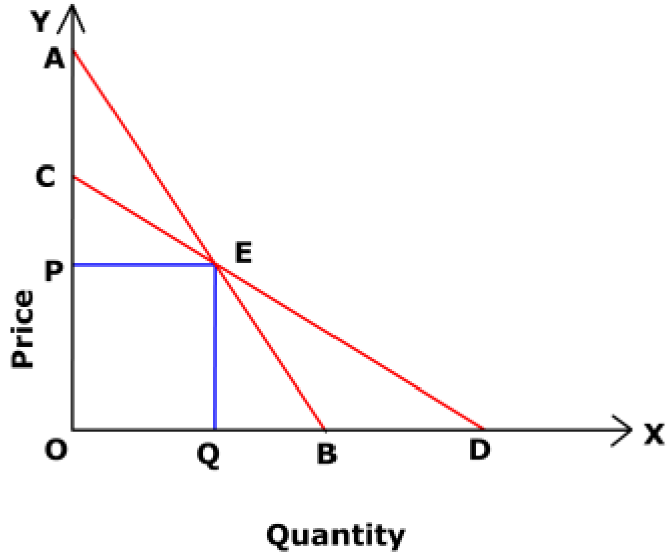
We will compare price elasticity on two demand curves.

Comparing Price Elasticity on two Intersecting Demand Curves:

In figure5 we compare elasticity at a given price where two demand curves AB and CD intersecting at point E. We noticed that demand curve CD is flatter than AB. For e.g. at price OP, corresponding to the point E, elasticity at point E on demand curve CD is OP/PC. Similarly at point E on demand curve AB elasticity is OP/PA. Hence, OP/PC > OP/PA because PC is less than PA.

Hence it is cleared that at every price on the flatter demand curve CD price elasticity is greater than that on the relatively steeper demand curve AB.

FIGURE 5:



Comparing Price Elasticity on two Parallel Demand Curves:

In figure 6 we compare elasticity at a given price where two demand curves AB and CD are parallel to each other. Since they are parallel to each other, so they have same slope. Here at price OP elasticities are different. Let draw a perpendicular from point R to point P on y axis. Thus two points are Q and R on two demand curves. Elasticity of AB curve at point Q is QB/QA and at point R is RD/RC. Because in a right angled triangle OAB, PQ is parallel to OB. Therefore,

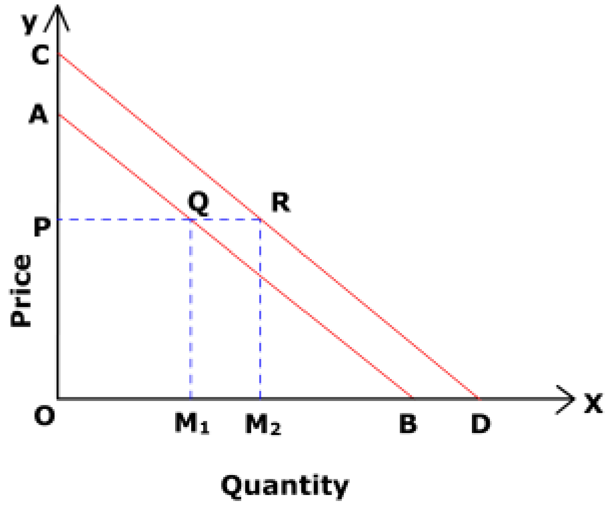
QB=QA=OP/PA. So elasticity at point Q on demand curve AB= OP/PA.

Similarly on point R on demand curve CD, elasticity= OP/PC. Because PC is greater than PA,

so, OP/PC< OP/PA.

Thus, at point R on the demand curve CD the elasticity is less than at point Q on demand curve AB, when two demand curves are parallel to each other.

FIGURE 6



7. Summary

The price elasticity of demand measures the responsiveness of percentage change in price to percentage change in quantity demanded. There are three popular methods for measuring price elasticity of demand named Straight line method, Outlay method and Arc elasticity. Straight line at a point is given by the ratio of the length of the line segment below the point to the length of the segment above it. In outlay method, total revenue is by definition equal to price times quantity (P*Q). The measure of elasticity of Demand between two finite points is known as Arc Elasticity. The Point Elasticity of demand is defined as proportionate change in quantity demanded in response to a very small change in price. Finally we compare the elasticity of the two intersecting and parallel demand curves.